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Effects of annealing atmosphere on the dielectric properties of barium strontium titanate glass-ceramics using impedance spectroscopy and thermally stimulated depolarization current technique

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Impedance spectroscopy (IS) analysis and thermally stimulated depolarization current (TSDC) study were carried out to investigate the effects of annealing atmosphere on the dielectric properties of barium strontium titanate ($(Ba,Sr)TiO_3$, BST) glass-ceramics. In the present work, the nitrogen-sintered BST glass-ceramics were annealed in air and oxygen, respectively.

IS analysis reveals the resistivity of air-annealed and O_2-annealed glass-ceramics samples increased by about two orders of magnitude compared to the N_2-sintered samples. An enhancement of insulation property was attributed to the decrease of oxygen vacancy concentration caused by the variation of annealing atmosphere. The activation energy calculated from the dc conductivity, complex impedance and modulus indicates the dielectric relaxation could be ascribed to the motion of dipoles related to oxygen vacancies. The result of TSDC shows the presence of two overlapping peaks which may associated with defect complex ($2Ti_{Ti}'$-$V_O^{\cdot\cdot}$) at lower temperature and space charge polarization at higher temperature. It was found that the current destiny and the concentration of dipole decreased when samples annealed in oxidation atmosphere. As a result, the decrease in oxygen vacancy concentration results in the decrease of conductivity.

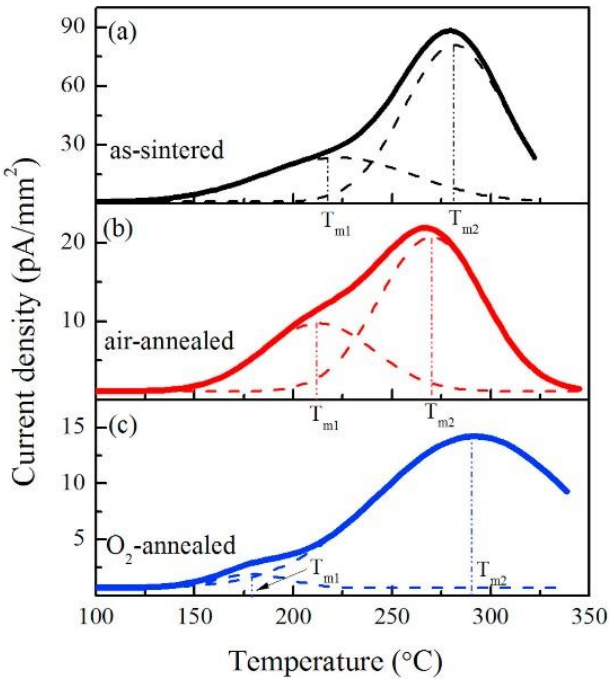

Figure 1. TSDC spectra of the BST glass-ceramics polarized at a dc electric field of 140 V/mm for 20 min at 250 ℃: (a) as-sintered, (b) air-annealed and (c) O_2-annealed. Solid lines are experimental curves while dashed lines are fitting curves.

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